Marine copepods shift in seasonal amplitude and synchronicity in the northwest Iberian shelf driven by meteo-hydrographic forcing

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Introduction

Copepods in the Galician coast represent the main group in zooplankton (more than 70% of the total abundance). Population dynamics theory predicts that species within a community are expected to exhibit compensatory dynamics, reflecting demographic stochasticity and density dependent processes. Empirical work, however, has shown that communities often exhibit synchronous dynamics, where all species rise and fall together. This has led to the suggestion that environmental forcing dominates species dynamics.

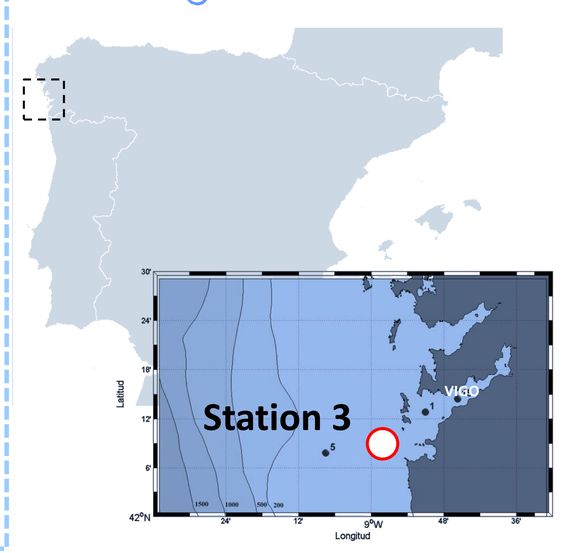
Located at the northern limit of the Canary upwelling system, the Galician coast ecosystem is largely influenced at the annual scale by seasonality of wind and precipitation regimes which cause dry weather and upwelling during summer and wet weather and downwelling during winter.

Zooplankton is expected to be strongly affected by these processes that control the availability of nutrients, primary production and export/retention mechanisms.

Objectives :

1) **Describe the cycle fluctuations** of copepod abundance and environmental drivers time-series
2) **Quantify the synchronicity** between copepod species at the annual scale and its year-to-year variability.
3) **Explore the relationship between phase angle spread and environment** drivers to identify the rules that shape the copepod community structure.

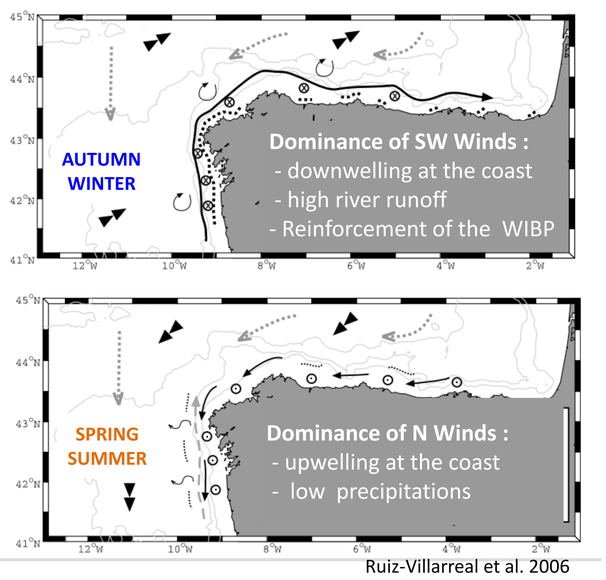
Study zone



Material and Methods

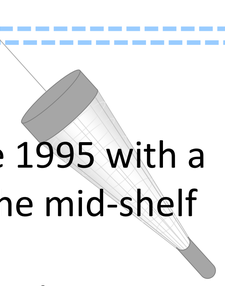
Environmental drivers

There are two seasonal contrasted situations, we select the **Upwelling index** and the amount of **precipitations** to reflect both seasonal scenarios



Ruiz-Villarreal et al. 2006

Zooplankton sampling



- Monthly sampling since 1995 with a **Bongo** oblique hauls at the mid-shelf (Vigo Station 3)
- **Taxonomic identification** by an expert at the species level.
- Copepod species present in more than 50 % of the samples :

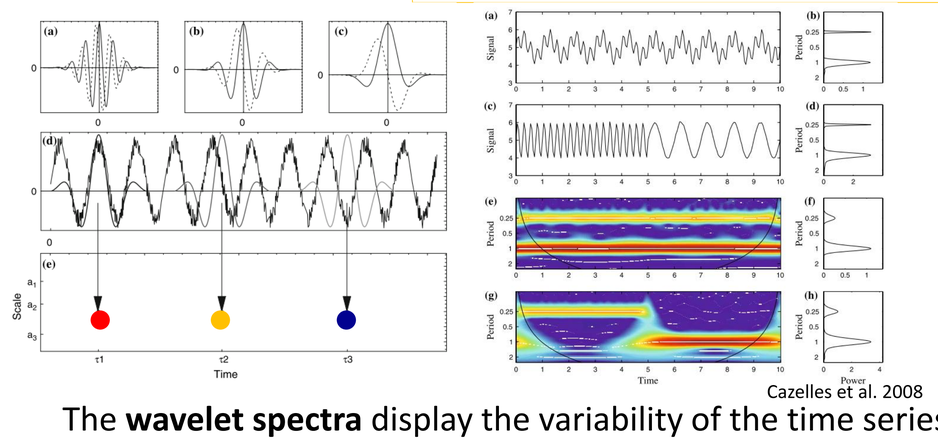
Acartia clausi
Calanus helgolandicus
Oithona plumifera
Paracalanus parvus
Pseudocalanus elongatus
Temora longicornis
Oncae media
Euterpina acutifrons
Centropages cherchidae

All 10 biotic and 2 abiotic series were regularized, detrended and standardized

Wavelet Transformation

- We used **wavelet analysis that** overcome the problems of non-stationarity in time series by performing a **local time-scale decomposition** of the signal

$$W_x(a,\tau) = \frac{1}{\sqrt{a}} \int_{-\infty}^{+\infty} x(t)\varphi^*\left(\frac{t-\tau}{a}\right)dt = \int_{-\infty}^{+\infty} x(t)\varphi^*_{a,\tau}(t)dt$$



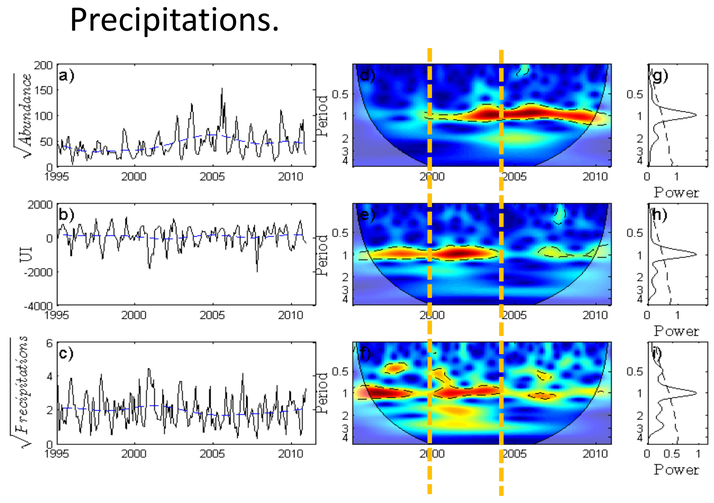
Cazelles et al. 2008

The **wavelet spectra** display the variability of the time series both in time and frequency domains.

- We **extract the phases** of all copepod species for the annual oscillation and compute the **variance** to quantify synchronicity. The lowest is the variance, the strongest is the synchronicity.

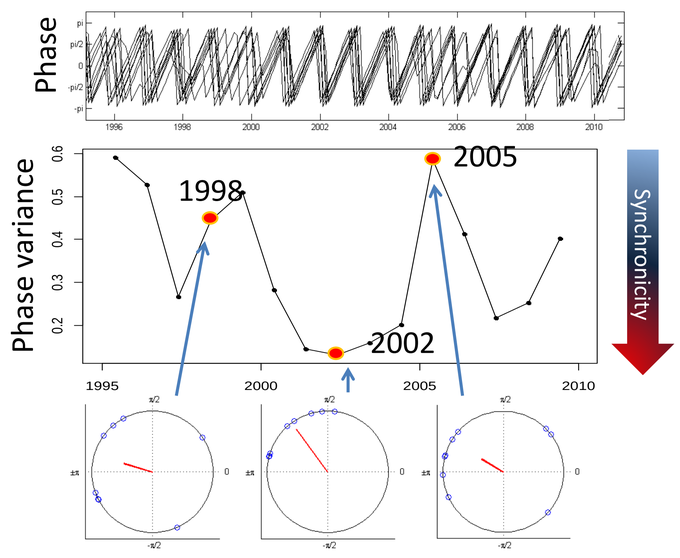
Results

1) Wavelet transformation of Copepod total abundance, Upwelling Index and Precipitations.



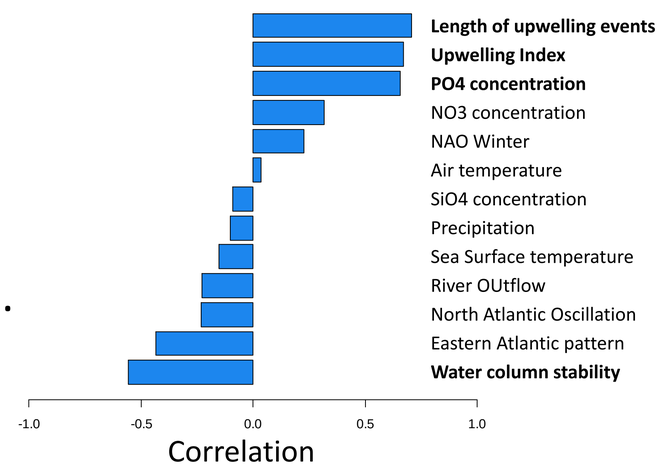
- Copepod abundance, Upwelling Index and Precipitations display a transient annual cycle.
- From 2000 to 2004 abiotic series present high amplitude of the annual component concomitant with the start of increase in copepod abundance.

2) Phase extraction of the 9 dominants copepod species.



- The degree of synchronicity (phase variance) fluctuates with time.
- From 2000 to 2004 phase variance is low : copepods species are highly synchronized

3) Preliminary exploration of environmental drivers of phase variance



- From the available set of data, phase variance is highly correlated with the length of upwelling events
  ➔ more synchronicity when upwelling events shorten.

Conclusions and Perspectives

From 2000 to 2004 the study zone experienced the highest amplitude of upwelling index and precipitation at the annual scale increasing the contrast between winters and summers. The enhanced continental inputs and retention in winter (downwelling) combined with the high inputs of nutrient in summer (upwelling) are susceptible to cause the tightly increase in Copepod abundance occurring in 2000. This increase is accompanied by a major synchronicity between copepod species. While synchronicity decreased after 2004 copepod abundance remained high until the end of the series.

The synchronicity appears related to the Upwelling intensity, but more closely to the duration of the upwelling events. Did the small scale variability prevent compensation dynamic? Is synchronicity the process by which community step to an other equilibrium?

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